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ON THE CORRELATION OF HABIT IN NEMOSCEROUS AND BRACHYCEROUS DIPTERA BETWEEN AQUATIC LARVÆ AND BLOOD-SUCKING ADULT FEMALES.

By C. H. TYLER TOWNSEND.

It is a rather striking fact that in most of the dipterous families whose adult females are of mammalian blood-sucking habit, the larvæ are commonly aquatic. Such larvæ breathe in various ways, but often by means of tracheal gills or vesicles. Especially is this correlation of habit evident in the older families of diptera, the Nemocera and those more nearly allied to them. It seems strange that such an apparent connection in habits in these families should have escaped the notice of previous observers, yet no one seems to have ever remarked upon it.

The following families possess such blood-sucking females. The known blood-sucking genera are starred, while all the other genera given possess mouth-parts capable of biting, though they are not so far known to suck blood.

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| | { | Simuliidæ : | Single genus <i>Simulium</i> .* |
| | | Çulicidæ : | <i>Megarrhina</i> *, <i>Culex</i> *, <i>Anopheles</i> *, <i>Aedes</i> ,
<i>Corethra</i> , <i>Mochlonyx</i> (European). |
| Orthorhapha
Nemocera. | | Chironomidæ : | <i>Ceratopogen</i> * (some spp.), <i>Terres-</i>
<i>thes</i> *, <i>Oecacta</i> *, <i>Chironomus</i> , <i>Tanypus</i> , <i>Diamesa</i> ,
<i>Chasmatonotus</i> , <i>Hydrobænus</i> , <i>Heteromyia</i> , <i>Coryno-</i>
<i>neura</i> (Eu.). In fact all the known genera except
<i>Clunio</i> (Eu.) have biting mouth parts. |
| | | Psychodidæ : | <i>Phlebotomus</i> * (Eu.), and perhaps some
other genera. |
| Orthorhapha
Brachycera. | { | Tabanidæ :* | All known genera, about forty in
number, are without exception blood-sucking in
habit in the female. |
| | | Leptidæ : | <i>Symphoromyia</i> *, <i>Leptis</i> , <i>Atherix</i> and
other genera. |
| Cyclorhapha. | { | Muscidæ : | <i>Stomoxys</i> *, <i>Hæmatobia</i> *, <i>Glossina</i> *
(the Tsetse fly of Africa). |

I exclude the HIPPOBOSCIDÆ and NYCTERIBIDÆ, as being degradedly parasitic in both sexes, and as not possessing a blood-sucking habit of

comparatively recent acquirement in the female sex. They suck not only mammalian blood (horses, sheep and bats), but also that of birds.

The larval habits of the genera above named, so far as known, are as follows:

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| Simulium : Larvæ live in water, usually swift running water. | Heteromyia : Unknown. |
| Megarrhina : In water. | Corynoneura : Unknown. |
| Culex : In water. | Phlebotomus : Probably aquatic, as some Psychodid larvæ live in water. |
| Anopheles : In water. | Tabanidæ : The larvæ of <i>Tabanus</i> live in water or in moist earth, and those of <i>Chrysops</i> probably in slimy mud and water. The larval habits of other genera are not known, but are doubtless the same. |
| Aedes : Unknown. | Symphoromyia : Unknown. |
| Corethra : In water. | Leptis : Moist earth. |
| Mochlonyx : In water. | Atherix : In water. |
| Ceratopogon : Some species live in water, others in foul vegetable matter. | Stomoxys : In horse dung. |
| Terresthes : Unknown. | Hæmatobia : In cow dung. |
| Oecacta : Unknown. | Glossina : Unknown. |
| Chironomus : Some species in water, others in earth and dung. | |
| Tanypus : In water. | |
| Diamesa : Unknown. | |
| Chasmatonotus : Unknown. | |
| Hydrobænus : In slimy mud. | |

The mode of larval respiration in the strictly aquatic forms, so far as known, is as follows: *Simulium* larvæ breathe by means of a tracheal network in the skin, also by tracheal vesicles at the anal extremity.

Chironomus, *Tanypus*, and the aquatic larvæ of *Ceratopogon* have a closed tracheal system, rudimentary and completely closed in *Chironomus*. In *Corethra* it is also rudimentary, and perhaps supplemented by respiration through the skin.

Culex, *Anopheles* and *Mochlonyx* have a pair of longitudinal tracheæ, ending in anal spiracles, through which they inhale air. They also, together with most Chironomidæ are provided with various branchial appendages.

Some Psychodid larvæ possess branchiæ of various shapes. Further notes of interest in this connection are the following: The European genus *Chunio* Haliday is the only known Chironomid genus in which the proboscis is rudimentary and almost entirely wanting.

The larvæ of Blepharoceridæ live in swift running water like those of *Simulium*, or in still swifter water. The mouth parts of the adults seem to be capable of biting.

Rhyphus, and some Bibionidæ, have biting mouth parts.

Going now to the Brachycera, we find that *Leptis* and *Atherix*, probably also other Leptidæ, possess biting mouth parts capable of sucking blood, but *Symphoromyia* is the only Leptid genus which has so far been recorded to practice this habit. I have observed its blood-sucking habit on San Francisco Mt., in Arizona.

Thereva has biting mouth parts much like a Tabanid. Its larvæ live in slimy mud or moist earth. Other Therevidæ have similar mouth parts, but no species are known to suck mammalian blood. The larvæ in general are said to live in fungi and decaying wood, and the adults to prey on other insects.

In this connection it will be well also to mention the mouth parts of the Asilidæ, which are fitted for piercing and sucking, but which are very different from those of the Tabanidæ. They are specially fitted for piercing the exoskeleton of insects, and differ strongly from the mouth parts of genera which pierce the skin of mammals.

To sum up, we have the following genera which are known to have aquatic larvæ and blood-sucking adult females: * *Simulium*, *Megarrhina*, *Culex*, *Anopheles*, *Ceratopogon*, *Phlebotomus* (probably), and many Tabanidæ genera. This list will doubtless in time be increased, as we have blood-sucking genera, of which the larval habits are unknown; and genera whose larvæ are known to live in water, but whose adults, while possessing mouth parts capable of biting, have never been observed to suck blood.

On the whole the rule seems to hold good in the Nemocera, nearly as good in the Brachycera, and not at all in the Cyclorhapha. The Muscid genera seem to offer a marked contrast. In other words it is in the oldest families that this correlation of habit obtains. These families doubtless originally sucked the plants (Culicidæ, Chironomidæ Simuliidæ, etc.), as has recently been suggested by Ficalbi, an Italian observer. The explanation of these facts is left to the future student. Why should this more or less complete correlation of habit exist in the older families of diptera?

* I am aware that males of *Culex* have been recorded as sucking blood.—C. H. T. T.